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Shaheen

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(54) **CUTTING HEAD OF A REAMER**

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(58) **Field of Classification Search** 408/223–224, 408/227, 229, 230; 407/116; *B23D 77/00, B23D 77/02, 77/12*
See application file for complete search history.

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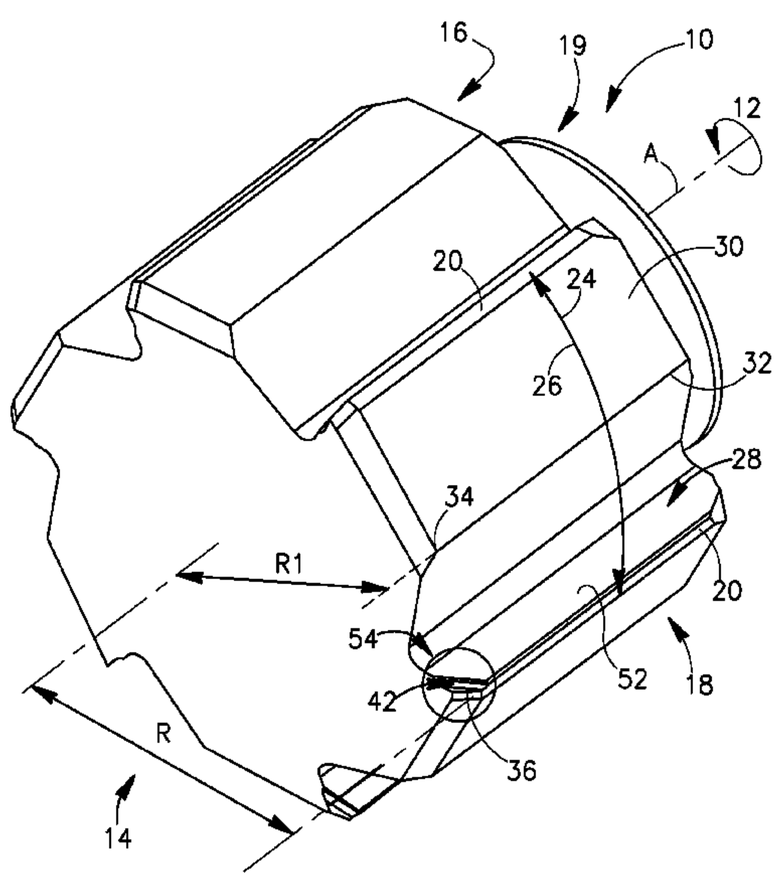
(57) **ABSTRACT**

A cutting head of a reamer has a cutting head forward end, a cutting head rear end distal the cutting head forward end, and a peripheral surface therebetween. The peripheral surface has at least two wiping pads that extend rearwardly from the cutting head forward end. At least one cutting section extends between two consecutive wiping pads and has a chip evacuation flute that extends rearwardly from the cutting head forward end and a cutting edge that is formed at the intersection of a rake surface and a relief surface. A chip former extends rearwardly from the rake surface. The chip former has a front portion that is slanted rearwardly and downwardly from the rake surface, and, a rear portion that is slanted rearwardly and upwardly with respect to the rake surface. A rear end of the rear portion joins the chip evacuation flute and form therewith a forming internal angle.

15 Claims, 4 Drawing Sheets



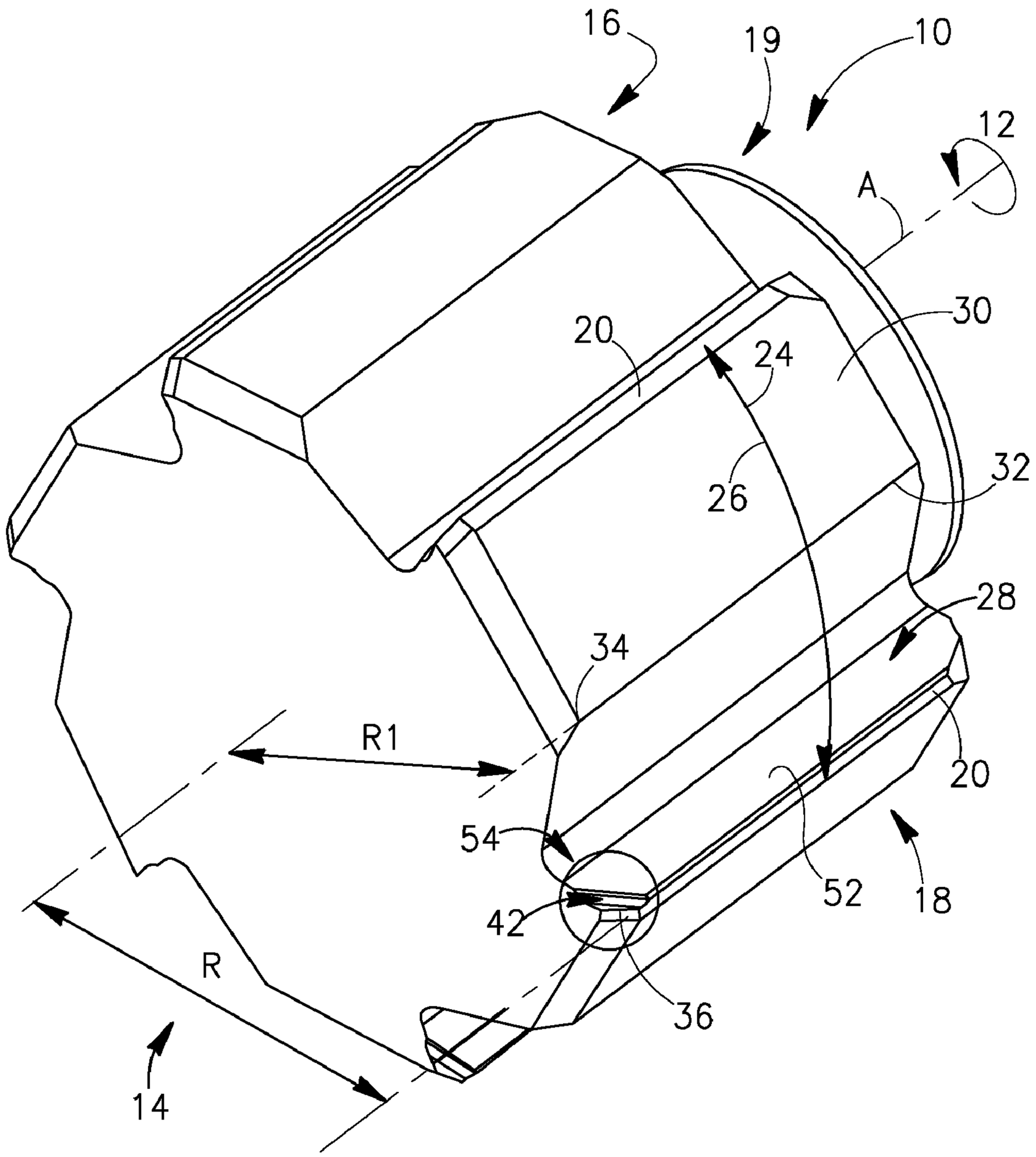


FIG. 1

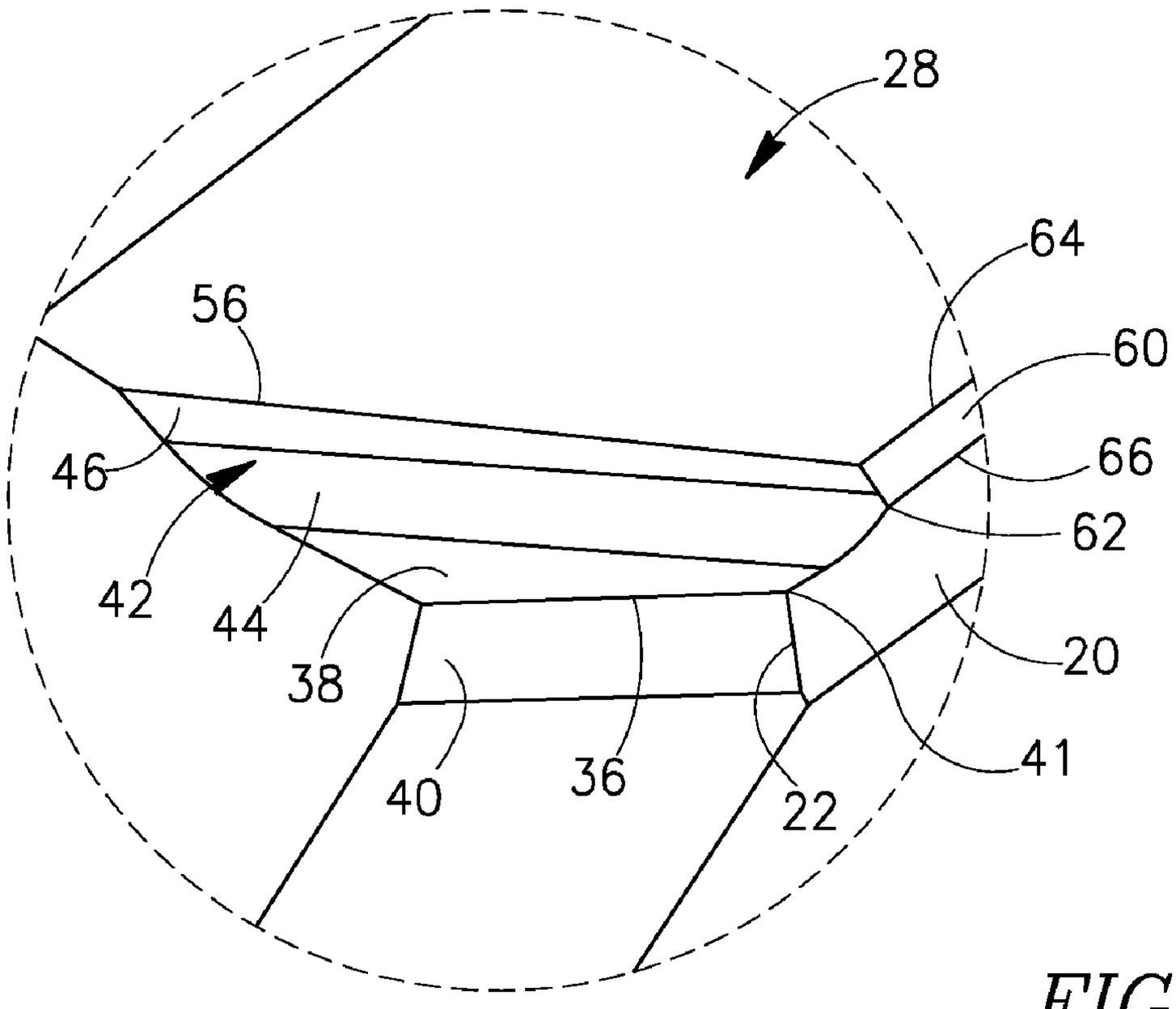


FIG.2

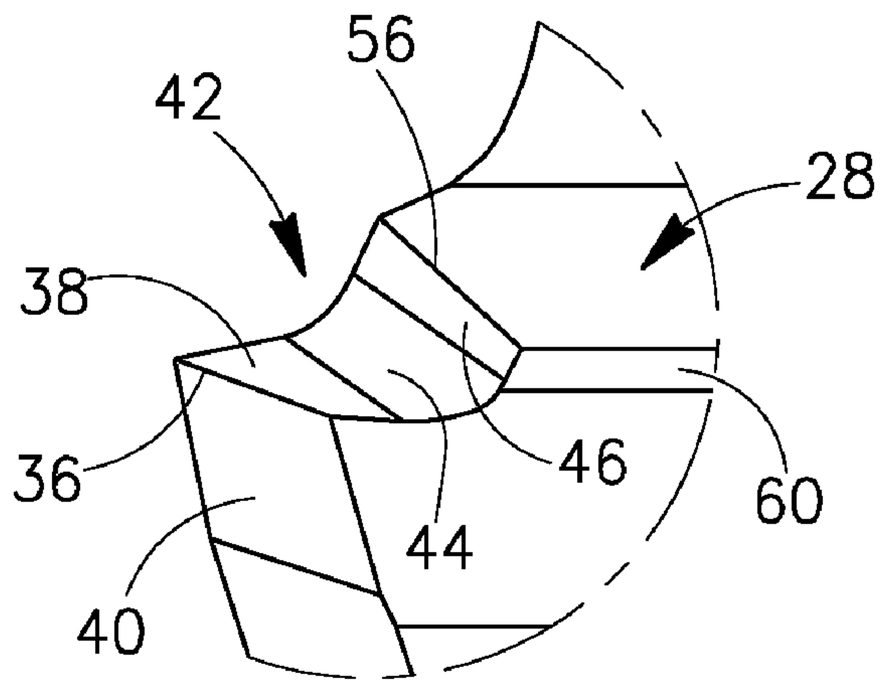


FIG.3

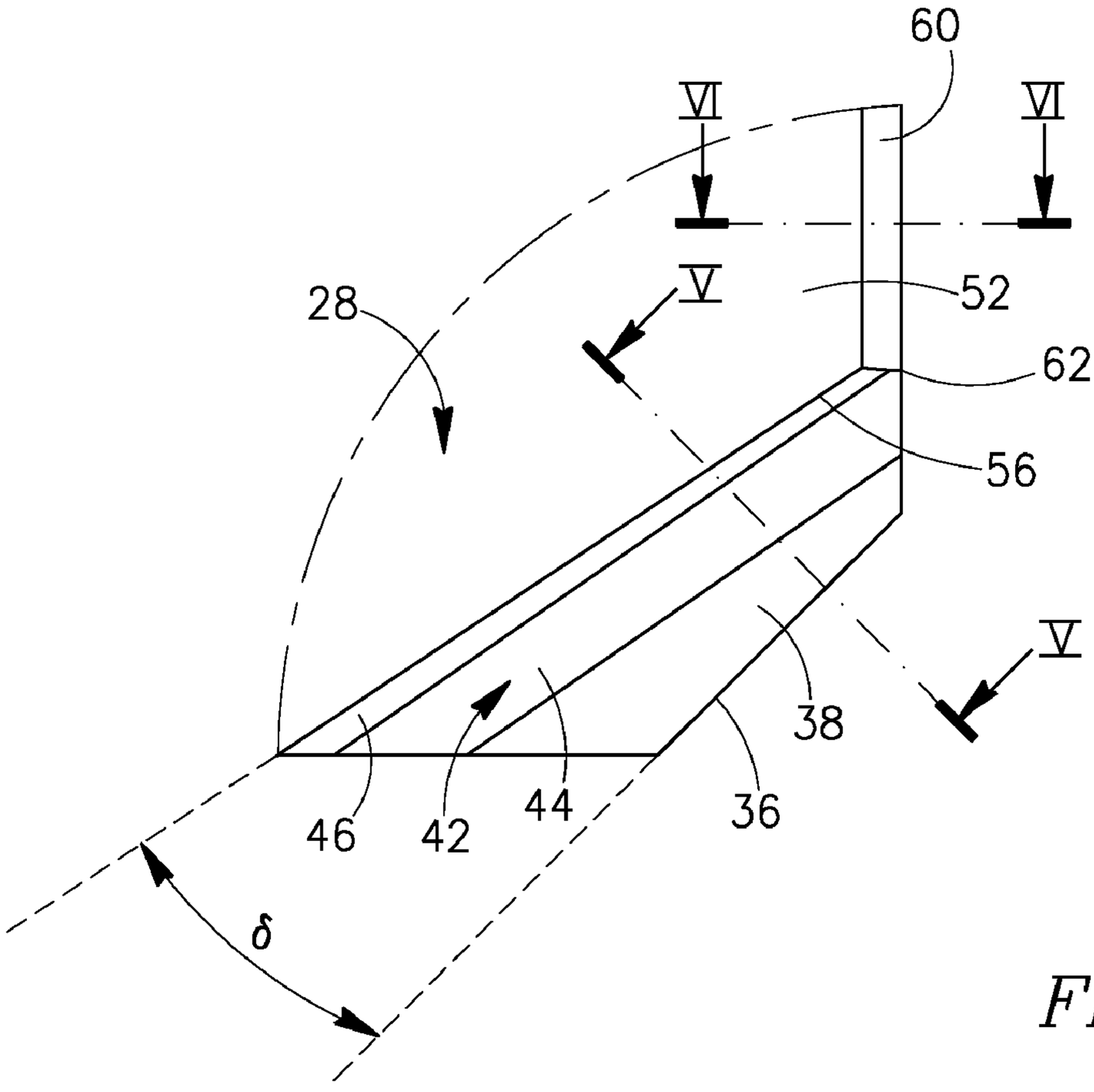

60
VI
VI
V
28
52
62
56
V
38
46
42
44
36
δ

FIG.4

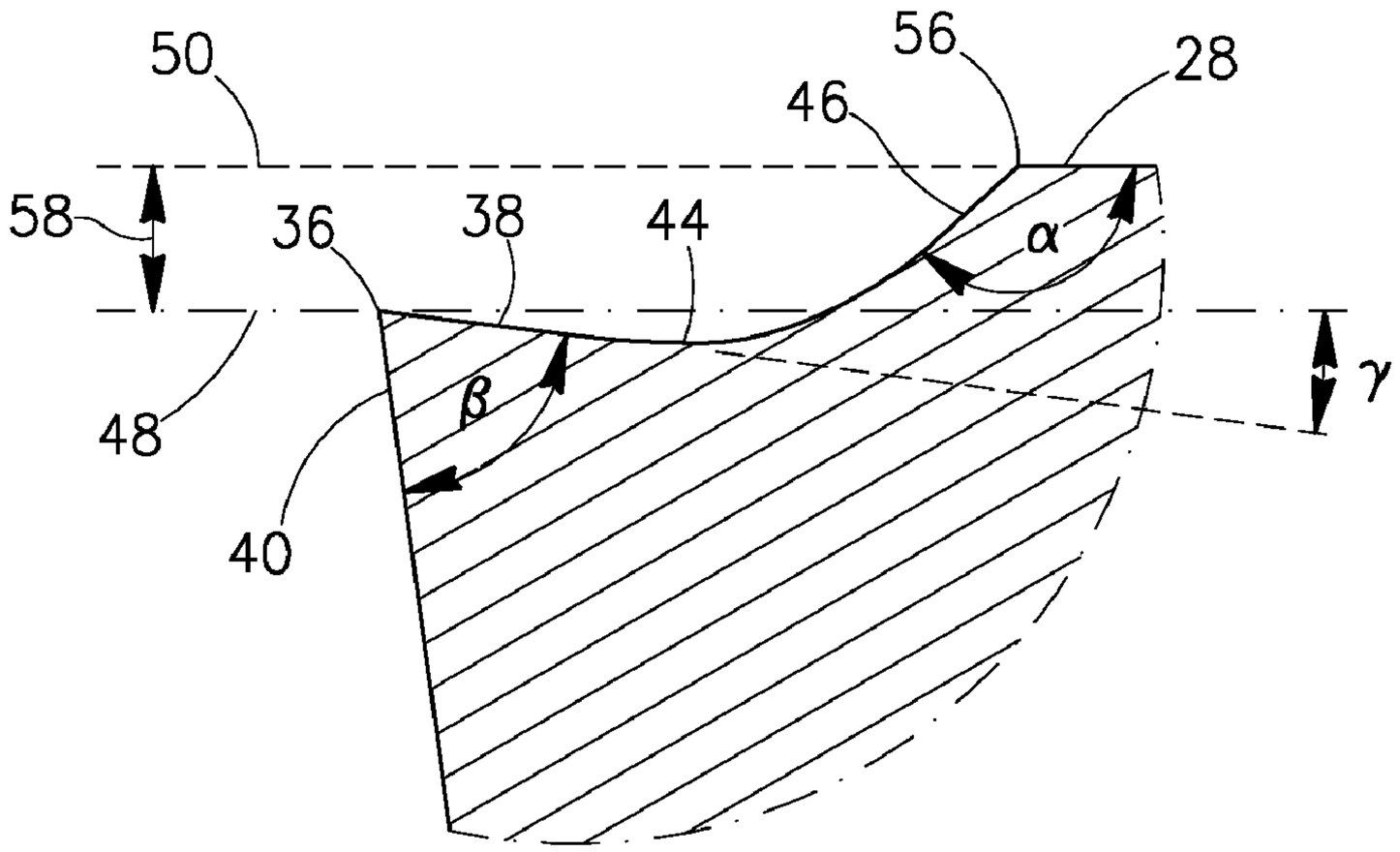

50
56
28
46
58
36
38
44
α
48
β
γ
40

FIG.5

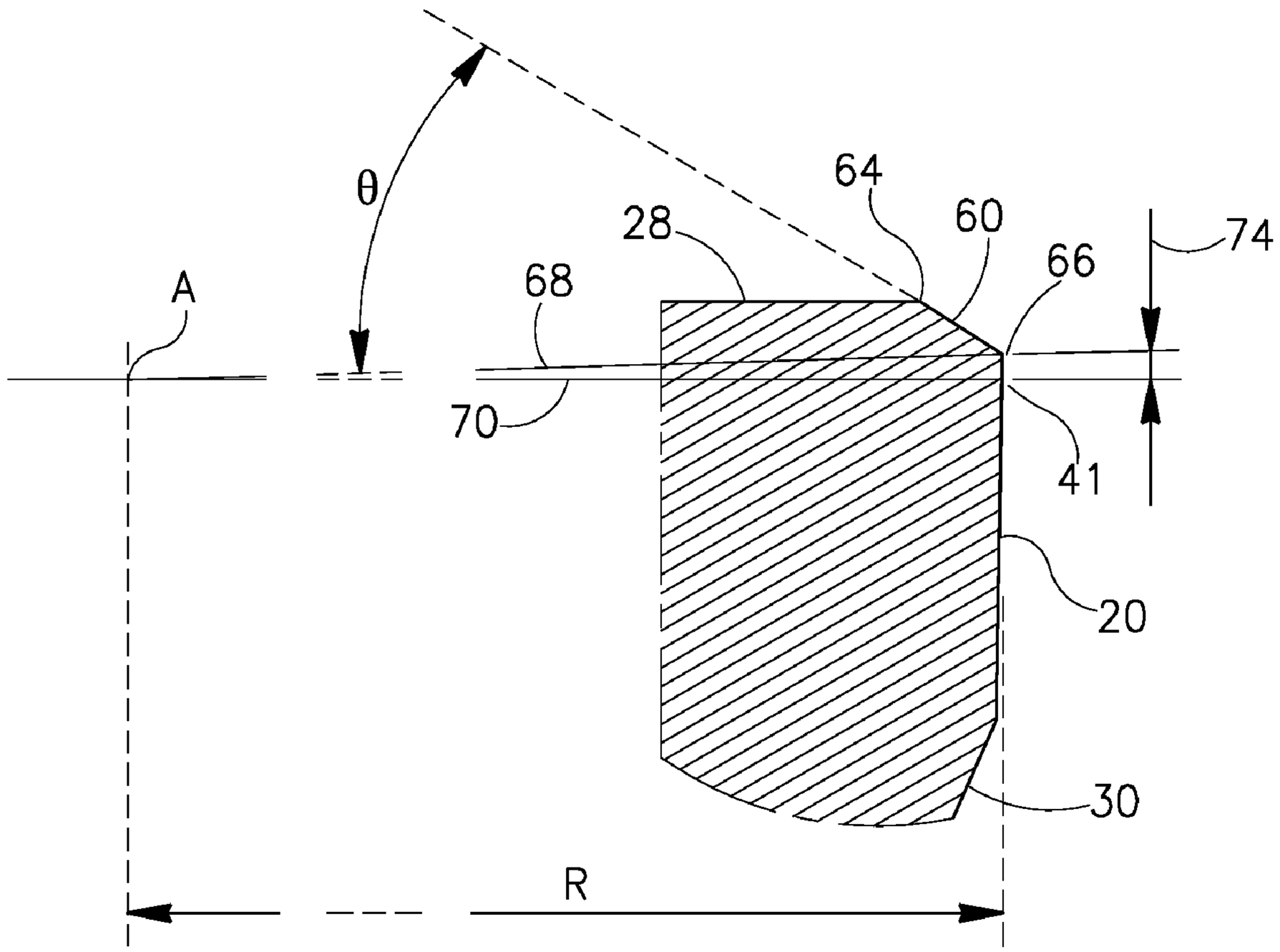


FIG. 6

CUTTING HEAD OF A REAMER

FIELD OF THE INVENTION

The present invention relates to rotary cutting tools for performing reaming operations.

BACKGROUND OF THE INVENTION

Known rotary cutting tools for performing reaming operations typically comprise a cutting head having an axis of rotation. The cutting head has a forward end and a peripheral surface extending rearwardly therefrom. The peripheral surface comprises at least two wiping pads extending rearwardly from the forward end. At least one cutting edge extends from the forward end to the peripheral surface. The cutting edge is formed at the intersection of a forward end of a chip evacuation flute and a relief surface, wherein the chip evacuation flute constitutes the rake surface of the cutting edge.

Such a construction encounters a disadvantage in that the chip that is produced during a cutting operation flows directly into the chip evacuation flute, thus lacking possibility to control the edge geometry and the chip formation, especially when different workpiece materials need to be machined. Consequently, a compromise within the cutting conditions should be made, thereby negatively affecting the productivity of the tool.

In known reaming cutting heads that are an integral one-piece solid carbide unit, the cutting edges are made at the intersection of a rake surface and a relief surface, whereby the rake surface and the relief surface are typically made by grinding at least at the vicinity of the cutting edge. At this kind of reaming cutting heads, the rake surface is an integral part of the chip evacuation flute and, therefore, the cutting edge is not provided with a chip former for controlling the chip formation.

It is an object of the present invention to provide a cutting head for a reamer that has a chip former.

SUMMARY OF THE INVENTION

In accordance with the present invention there is provided a cutting head of a reamer having an axis of rotation A and a defined direction of rotation, the cutting head comprising:

a cutting head forward end, a cutting head rear end distal the cutting head forward end and a peripheral surface therebetween, the peripheral surface comprising at least two wiping pads extending rearwardly from the cutting head forward end, the peripheral surface between two consecutive wiping pads forming a peripheral section, at least one peripheral section forming a cutting section, the cutting section comprising:

a chip evacuation flute that extends rearwardly from the cutting head forward end,

a cutting edge formed at the intersection of a rake surface, that generally faces the direction of rotation, and a relief surface, the cutting edge extends from the adjacent wiping pad to the cutting head forward end and is transversely directed to the axis of rotation, wherein:

a chip former extends rearwardly from the rake surface.

Generally, the chip former has a front portion and a rear portion, the front portion of the chip former is slanted rearwardly from the rake surface, the rear portion of the chip former is slanted rearwardly and upwardly with respect to the rake surface, a rear end of the rear portion joins the chip evacuation flute and forms therewith a forming internal angle (α).

Typically, the forming internal angle (α) is in the range of 100° to 150°.

Generally, the front portion of the chip former is slanted rearwardly and downwardly at a chip forming angle (γ) with respect to a first imaginary line that passes through the cutting edge and is parallel to a second imaginary line that is tangent to the chip evacuation flute at a front leading surface of the chip evacuation flute, as seen in a cross-section of the chip former taken in a plane perpendicular to the cutting edge.

Typically, the chip forming angle (γ) is in the range of 0° to 30°.

If desired, the cutting edge is distanced a first tangential distance from a second imaginary line that is tangent to the chip evacuation flute at a front leading surface of the chip evacuation flute, as seen in a cross-section of the chip former taken in a plane perpendicular to the cutting edge.

Typically, the first tangential distance is in the range of 0.0 mm to 0.3 mm.

In some embodiments, the chip former extends rearwardly and radially inwardly from the rake surface.

If desired, an axial land extends rearwardly from a radially outermost rear end of the chip former, the axial land joins the chip evacuation flute at a leading edge of the axial land and the wiping pad at a trailing edge of the axial land.

Generally, a cutting edge wedge angle (β) is formed between the rake surface and the relief surface, as seen in a cross-section of the chip former taken in a plane perpendicular to the cutting edge.

Typically, the cutting edge wedge angle (β) is in the range of 50° to 100°.

In some embodiments, the rear end of the rear portion of the chip former forms a chip former rear end angle (δ) with the cutting edge, as seen in a plan view of the chip former.

Typically, the chip former rear end angle (δ) is in the range of 0° to 20°.

Generally, the axial land forms an axial land angle (θ) with a radial line that extends from the trailing edge of the axial land to the axis of rotation, as seen in a cross-section of the cutting head taken in a plane perpendicular to the axial land.

Typically, the axial land angle (θ) is in the range of 5° to 85°.

Advantageously, the trailing edge of the axial land is located a second tangential distance higher than a radially outermost end of the cutting edge, as seen in a front view of the cutting head.

Typically, the cutting head is an integral one-piece solid carbide unit.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention and to show how the same may be carried out in practice, reference will now be made to the accompanying drawings, in which:

FIG. **1** is a perspective view of a cutting head of a reamer in accordance with the present invention;

FIG. **2** is an enlarged view of the encircled chip former of FIG. **1**;

FIG. **3** is a side perspective view of the chip former of FIG. **2**;

FIG. **4** is a plan view of the chip former of FIG. **2**;

FIG. **5** is a cross-sectional view of the chip former taken along line V-V in FIG. **4**; and

FIG. **6** is a cross-sectional view of the axial land taken along line VI-VI in FIG. **4**.

DETAILED DESCRIPTION OF THE INVENTION

Attention is drawn to the figures. A cutting head **10** of a reamer in accordance with the present invention may be

formed as an integral part of a tool holder, fixedly brazed to a tool holder, or, may be detachably connected thereto. The cutting head **10** may be integrally made from sintering carbide powders.

The cutting head **10** has an axis of rotation A and a defined direction of rotation **12**. The cutting head **10** has a cutting head forward end **14**, a cutting head rear end **16** and a peripheral surface **18** therebetween. The cutting head **10** may also have a mounting portion **19** which extends rearwardly of the cutting head rear end **16**. The peripheral surface **18** comprises a plurality of wiping pads **20** that extend rearwardly from the cutting head forward end **14**. Each of the wiping pads **20** has a forwardmost end **22** that defines a cutting radius R. The peripheral surface **18** between two consecutive wiping pads **20** forms a peripheral section **24**. According to a specific embodiment of the present invention, each of the peripheral sections **24** functions as a cutting section **26**. However, there are embodiments wherein only one peripheral section functions as a cutting section. A cutting section is a peripheral section having cutting capabilities. The construction of a cutting section **26** will now be described in detail.

A chip evacuation flute **28** extends rearwardly from the cutting head forward end **14** to the cutting head rear end **16**. A clearance surface **30** circumferentially precedes the chip evacuation flute **28** and joins therewith at a clearance edge line **32**.

A cutting edge **36** is formed at the intersection of a rake surface **38** that generally faces the direction of rotation **12**, and a relief surface **40** that extends circumferentially behind the rake surface **38**. The cutting edge **36** extends from an adjacent wiping pad **20** to the cutting head forward end **14** and is transversely directed to the axis of rotation A. A radially outermost end **41** of the cutting edge **36** defines a cutting radius R. The forwardmost end **22** of the wiping pad **20** stays on the cutting radius R. A radial extremity **34** of the clearance edge line **32** is distanced a first radial distance R1 from the axis of rotation A. The first radial distance R1 is smaller than the cutting radius R.

A chip former **42** extends rearwardly and radially inwardly from the rake surface **38**. The chip former **42** has a front portion **44** and a rear portion **46**. The front portion **44** of the chip former **42** is slanted rearwardly and downwardly at a chip forming angle γ with respect to a first imaginary line **48**. The first imaginary line **48** passes through the cutting edge **36** and is parallel to a second imaginary line **50**. The second imaginary line **50** is tangent to the chip evacuation flute **28** at a front leading surface **52** of the chip evacuation flute **28** and at a front portion **54** of the chip evacuation flute **28**, as seen in a cross-section of the chip former **42** taken in a plane perpendicular to the cutting edge **36**. Typically, the chip forming angle γ is in the range of 0° to 30°. In one embodiment, the chip forming angle γ is in the range of 5° to 15°.

The rear portion **46** of the chip former **42** is slanted rearwardly and upwardly with respect to the rake surface **38**. A rear end **56** of the rear portion **46** of the chip former **42** joins the chip evacuation flute **28** and forms therewith a forming internal angle α. Typically, the forming internal angle α is in the range of 100° to 150°. In one embodiment, the forming internal angle α is in the range of 115° to 135°.

In order to increase the efficiency of the chip former **42**, the cutting edge **36** is distanced a first tangential distance **58** from the second imaginary line **50**, as seen in a cross-section of the chip former **42** taken in a plane perpendicular to the cutting edge **36**. In one embodiment, the first tangential distance **58** may be in the range of 0.0 to 0.3 mm.

In order to assure the desired geometry of the chip former **42** adjacent the wiping pad **20**, the cutting head **10** is provided with an axial land **60**. The axial land **60** extends rearwardly from a radially outermost rear end **62** of the chip former **42**. The axial land **60** joins the chip evacuation flute **28** at a leading edge **64** of the axial land **60** and the wiping pad **20** at a trailing edge **66** of the axial land **60**. The axial land **60** forms an axial land angle θ with a first radial line **68** extending from the trailing edge **66** of the axial land **60** to the axis of rotation A, as seen in a cross-section of the cutting head **10** taken in a plane perpendicular to the axial land **60**. Typically, the axial land angle θ is in the range of 5° to 85°. In one embodiment, the axial land angle θ is in the range of 20°to 70°. In another embodiment, the axial land angle θ is in the range of 35° to 55°.

FIG. **6** is a cross-sectional view of the axial land **60** taken perpendicularly to the axial land **60**, i.e., when the cutting head **10** is viewed from the cutting head forward end **14**. Therefore, for sake of clarity, a second radial line **70** extending from the radially outermost end **41** of the cutting edge **36** to the axis of rotation A is shown in FIG. **6**, even though it is not in the plane of the cross-section. The second radial line **70** is of the length of the cutting radius R, however, since the axis of rotation A is located outside the figure, the first radial line **68**, the second radial line **70** and the cutting radius R are marked partially with dashed lines to represent that their actual length is much larger.

As seen in FIG. **6**, the trailing edge **66** of the axial land **60** is located a second tangential distance **74** above the radially outermost end **41** of the cutting edge **36**. The fact that the trailing edge **66** of the axial land **60** is located higher than the radially outermost end **41** of the cutting edge **36** as seen in a front view of the cutting head **10** enables to assure the desired geometry of the chip former **42** and adequate clearance of the non cutting portions of the cutting head **10** from the walls of a workpiece to be machined.

A cutting edge wedge angle β is formed between the rake surface **38** and the relief surface **40**, as seen in a cross-section of the chip former **42** taken in a plane perpendicular to the cutting edge **36**. Typically, the cutting edge wedge angle β is in the range of 50° to 100°. In one embodiment, the cutting edge wedge angle β is in the range of 60° to 90°. In another embodiment, the cutting edge wedge angle β is in the range of 65° to 80°.

It is advantageous to design the radial extent of the chip former **42** to the varying cutting speed along the length of the chip former **42** during machining. Therefore, the rear end **56** of the rear portion **46** of the chip former **42** forms a chip former rear end angle δ with the cutting edge **36**, as seen in a plan view of the chip former **42**. Typically, the chip former rear end angle δ is in the range of 0° to 20°. In one embodiment, the chip former rear end angle δ is in the range of 5° to 15°. The rear end **56** of the rear portion **46** of the chip former **42** does not have to be a straight line, rather, it may have other geometries depending on the cutting requirements of the cutting head **10**.

Although the present invention has been described to a certain degree of particularity, it should be understood that various alterations and modifications could be made without departing from the spirit or scope of the invention as hereinafter claimed. For example, the cutting head may be formed by flutes that extend peripherally between two adjacent wiping pads and extend rearwardly in a straight or spiral manner.

What is claimed is:

1. A cutting head (**10**) of a reamer having an axis of rotation (A) and a defined direction of rotation (**12**), the cutting head (**10**) comprising:

a cutting head forward end (**14**), a cutting head rear end (**16**) distal the cutting head forward end (**14**) and a

peripheral surface (**18**) therebetween, the peripheral surface (**18**) comprising at least two wiping pads (**20**) extending rearwardly from the cutting head forward end (**14**), a peripheral section located between two consecutive wiping pads (**20**), at least one peripheral section (**24**) being a cutting section (**26**), the cutting section (**26**) comprising:

a chip evacuation flute (**28**) that extends rearwardly from the cutting head forward end (**14**); and

a cutting edge (**36**) formed at the intersection of a rake surface (**38**) that generally faces the direction of rotation (**12**), and a relief surface (**40**), the cutting edge (**36**) extending from the adjacent wiping pad (**20**) to the cutting head forward end (**14**) and being transversely directed to the axis of rotation (A), wherein:

a chip former (**42**) extends rearwardly from the rake surface (**38**);

an axial land (**60**) extends rearwardly from a radially outermost rear end (**62**) of the chip former (**42**), the axial land (**60**) joins the chip evacuation flute (**28**) at a leading edge (**64**) of the axial land (**60**) and the wiping pad (**20**) at a trailing edge (**66**) of the axial land (**60**);

the trailing edge (**66**) of the axial land (**60**) is located a second tangential distance (**74**) higher than a radially outermost end (**41**) of the cutting edge (**36**), as seen in a front view of the cutting head (**10**).

2. The cutting head (**10**) according to claim **1**, wherein the chip former (**42**) has a front portion (**44**) and a rear portion (**46**), the front portion (**44**) of the chip former (**42**) is slanted rearwardly from the rake surface (**38**), the rear portion (**46**) of the chip former (**42**) is slanted rearwardly and upwardly with respect to the rake surface (**38**), a rear end (**56**) of the rear portion (**46**) joins the chip evacuation flute (**28**) and forms therewith a forming internal angle (α).

3. The cutting head (**10**) according to claim **2**, wherein the forming internal angle (α) is in the range of 100° to 150°.

4. The cutting head (**10**) according to claim **2**, wherein the front portion (**44**) of the chip former (**42**) is slanted rearwardly and downwardly at a chip forming angle (γ) with respect to a first imaginary line (**48**) that passes through the cutting edge (**36**) and is parallel to a second imaginary line (**50**) that is tangent to the chip evacuation flute (**28**) at a front leading surface (**52**) of the chip evacuation flute (**28**), as seen in a cross-section of the chip former (**42**) taken in a plane perpendicular to the cutting edge (**36**).

5. The cutting head (**10**) according to claim **4**, wherein the chip forming angle (γ) is in the range of 0° to 30°.

6. The cutting head (**10**) according to claim **2**, wherein the rear end (**56**) of the rear portion (**46**) of the chip former (**42**) forms a chip former rear end angle (δ) with the cutting edge (**36**), as seen in a plan view of the chip former (**42**).

7. The cutting head (**10**) according to claim **6**, wherein the chip former rear end angle (δ) is in the range of 0° to 20°.

8. The cutting head (**10**) according to claim **1**, wherein the cutting edge (**36**) is distanced a first tangential distance (**58**) from a second imaginary line (**50**) that is tangent to the chip evacuation flute (**28**) at a front leading surface (**52**) of the chip evacuation flute (**28**), as seen in a cross-section of the chip former (**42**) taken in a plane perpendicular to the cutting edge (**36**).

9. The cutting head (**10**) according to claim **8**, wherein the first tangential distance (**58**) is in the range of 0.0 mm to 0.3 mm.

10. The cutting head (**10**) according to claim **1**, wherein the axial land (**60**) forms an axial land angle (θ) with a radial line (**68**) that extends from the trailing edge (**66**) of the axial land (**60**) to the axis of rotation (A), as seen in a cross-section of the cutting head (**10**) taken in a plane perpendicular to the axial land (**60**).

11. The cutting head (**10**) according to claim **10**, wherein the axial land angle (θ) is in the range of 5° to 85°.

12. The cutting head (**10**) according to claim **1**, wherein a cutting edge wedge angle (β) is formed between the rake surface (**38**) and the relief surface (**40**), as seen in a cross-section of the chip former (**42**) taken in a plane perpendicular to the cutting edge (**36**).

13. The cutting head (**10**) according to claim **12**, wherein the cutting edge wedge angle (β) is in the range of 50° to 100°.

14. The cutting head (**10**) according to claim **1**, wherein the chip former (**42**) extends rearwardly and radially inwardly from the rake surface (**38**).

15. The cutting head (**10**) according to claim **1**, wherein the cutting head (**10**) is an integral one-piece solid carbide unit.

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